HHS Public Access
Author manuscript
Am J Geriatr Psychiatry. Author manuscript; available in PMC 2016 July 01.

Published in final edited form as:
Am J Geriatr Psychiatry. 2015 July ; 23(7): 684–697. doi:10.1016/j.jagp.2015.01.003.

Sociodemographic Correlates of Cognition in the Multi-Ethnic Study of Atherosclerosis (MESA)

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Conflicts of Interest
No authors have conflicts of interest to report.

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Abstract

Objectives—To describe the methodology utilized to evaluate cognitive function in the Multi-Ethnic Study of Atherosclerosis (MESA) and to present preliminary results by age, gender and race/ethnicity.

Design—Cross-sectional measurements of a prospective observational cohort.

Setting—Residents of 6 US communities free of cardiovascular disease at baseline (2000-02).

Participants—4,591 adults who completed the 5th MESA clinical examination in 2011-12, mean age 70.3 (SD 9.5) years, 53.1% women, and 40.7% Non-Hispanic White, 26.4% Non-Hispanic Black, 21.4% Hispanic, and 11.5% Chinese.

Measurements—The cognitive battery consisted of the Cognitive Abilities Screening Instrument (version 2) to evaluate global cognition, the Digit Symbol Code for processing speed and Digit Spans Forward and Backward to assess memory. Demographic, socioeconomic, and cultural covariates were also collected for descriptive statistics and multivariate modeling.

Results—Associations between socio-economic factors and cognition revealed that age, race/ethnicity, education, occupational status, household income, health insurance type, household size, place of birth, years and generation in U.S., and the presence of the APOE4 allele were significantly associated with performance on the cognitive tests although patterns varied by specific test, racial/ethnicity, and socio-cultural factors.

Conclusions—As many of the influencing cultural and socioeconomic factors measured here are complex, multifactorial, and may not be adequately quantified, caution has been recommended with regard to comparison and interpretation of racial/ethnic group performance differences from these cross-sectional models. These data provide a baseline for future exams and more comprehensive longitudinal analyses of the contributions of subclinical and clinical diseases to cognitive function and decline.

Keywords

MESA; cognition; methods; multi-ethnic; race; socioeconomic; cultural

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As the population ages and racial diversity increases in the United States, there is a need to better understand trends in cognitive function and decline in older adults across ethnic groups comprising the U.S. population. Dramatic growth in the number of “oldest old”, adults age 85 years and above, across all racial and ethnic groups is contributing to an increase in the rate of dementias including Alzheimer's disease (1,2). The fastest sector of the growing minority elderly groups are Hispanic elders with a 328% increase and Asian and Pacific Islanders with 285% increase in comparison to 81% increase among Caucasians and 131% increase among African-Americans by 2030. Studies have been conducted that examine ethnic differences in the prevalence and incidence of dementia, most commonly among non-Hispanic Whites, non-Hispanic Blacks, and Hispanics, with varied results (3).

Although there is no consensus, a growing body of evidence suggests that dementia may disproportionately affect racial/.ethnic minority groups in the US (4-8). The Alzheimer Association estimates that in non-Hispanic Blacks age 65 and older, the prevalence of AD and other dementias is approximately twice the rate of Whites; the rate in Hispanics is about 1.5 times greater than that of non-Hispanic Whites (6). The reasons for these apparent differences in racial/ethnicity and their implications are poorly understood at this time.

Cognitive function is multi-dimensional and is affected by a large number of biological and social factors. While objectively measured influences such as genetics and comorbid diseases are involved, social and cultural factors may also play a role that is more difficult to disentangle (3). The strong relationship between education and neuropsychological test performance has been well documented in a meta-analysis; however, risk of dementia associated with years of education appears to vary by population (9). The relationship between education and dementia occurred when years of education better reflected cognitive capacity. Assessment of different cognitive functioning along with social and cultural factors may help clarify the relationship between cognitive aging and race/ethnicity.

The Multi-Ethnic Study of Atherosclerosis (MESA) provides a unique opportunity to examine how clinical markers and diseases, as well as social and cultural factors, are related to cognitive function and decline, and whether these patterns differ across racial and ethnic groups. The primary objective of this manuscript is to describe the methodology utilized to evaluate cognitive function in MESA at Exam 5 and to present descriptive results by age, gender and race/ethnicity. We also present preliminary associations of cognitive test scores by demographic variables in a sub-sample of participants to set the stage for more comprehensive analyses. These results will provide the background for subsequent manuscripts to address risk factors related to cognitive function and decline with aging, using the rich data available from five clinical examinations in four racial and ethnic samples in MESA.

METHODS

The MESA Cohort

The Multi-Ethnic Study of Atherosclerosis (MESA) is a prospective observational cohort comprised of 6,814 adults age 45-84 years in 2000-2002 who self-reported their race/ethnicity as Non-Hispanic White, Non-Hispanic Black, Hispanic or Chinese (10). Adults between the ages of 45-84 years who were free of clinically apparent CVD were recruited from 6 US communities: Baltimore City and Baltimore County, Maryland; Chicago, Ill; Forsyth County, North Carolina; Los Angeles County, California; Northern Manhattan and the Bronx, New York; and St. Paul, Minn. Each field site recruited from locally available sources, which included lists of residents, lists of dwellings, and telephone exchanges. The primary objective of MESA is to determine the characteristics related to the prevalence and progression of subclinical CVD to clinical CVD focusing on age, gender and race/ethnicity differences in subclinical disease prevalence, risk of progression, and rates of clinical CVD (10).

Measurements

Data were collected using standardized questionnaires for assessing demographics including age, self-identified ethnicity, education, household income, health insurance, occupation, medical history and health behaviors. Cultural background questions included place of birth, years living in the US, and primary language spoken in the home. Participants were allowed to select the language to be used at the visit from English, Spanish or Chinese (Mandarin or Cantonese). Between baseline and 2011, four additional follow-up examinations were conducted to repeat measurements of the initial examination and to collect new clinical procedures. All participants provided informed consent and institutional review board approval was received at all MESA sites and reading centers.

Assessment of Cognition

Cognitive function was evaluated during the 5th MESA follow-up exam using three standardized and validated tests to address several cognitive domains: global cognitive function, processing speed, and memory. The neuropsychological tests utilized are described below:

Cognitive Abilities Screening Instrument (CASI, version 2)—The CASI was selected to measure global cognitive function because it was explicitly developed for cross-cultural use. It has been translated into Japanese, Chinese, Spanish, and French and has been utilized in these ethnic populations (11-13). The CASI includes 25 items which represent nine cognitive domains including attention, concentration, orientation, short-term memory; long-term memory, language, visual construction, verbal fluency and abstraction/judgment. Individual items were summed to provide an overall cognitive function score ranging from 0 to 100.

Digit Symbol Coding (DSC) is a subtest of the Wechsler Adult Intelligence Scale-III (17) that measures how quickly simple perceptual or mental operations can be performed, which along with working memory (see next test) mediate a large proportion of age related variance in memory (18,19), reasoning (18) and other cognitive abilities (20). A key at the top of the test page shows a series of nine simple symbols (e.g., +, >) that are paired with numbers (1-9). For 120 seconds the participant copies the correct symbol into an empty box directly below another box containing one of the numbers which are randomly ordered. The DSC score ranges from 0 to 133.

Digit Span (DS) is also a sub-test of the Wechsler Adult Intelligence Scale-III (17) that assesses working memory. This test is administered in two parts and requires the participant to repeat gradually increasing spans of numbers (e.g., 2-7-4) first forwards (14 trials maximum) and then backwards (14 trials maximum). For each given span length, two trials are administered and a point is awarded for each correctly recalled span. Scores range from 0 to 28.

General instructions for the cognitive exam were translated into Spanish and Mandarin Chinese and then independently back-translated by native speakers and pre-tested. A centralized training was held prior to the 5th MESA exam to standardize administration.

Examiners were certified to administer the tests and conference calls were held throughout the data collection period to maintain high fidelity. Additional training was provided as needed.

Estimation of the ApoE4 Allele

ApoE isoforms were estimated from SNPs rs429358 and rs7412 from the genotyping conducted in MESA participants in 2013. The ApoE isoforms were estimated from these SNPs according to the following algorithm:

	rs7412		
rs429358	**AA**	**BA**	**BB***
BB	E4/E4 (Alz)	E2/E4 (rare, ~1%)	--
BA	E3/E4	E2/E4 (rare, ~1%)	--
AA	E3/E3 (most common)	E2/E3	--

*must be E2/E2 if BB is on rs7412; also the BB at rs429358 and BB at rs7412 combination has not ever been observed.

A quality control comparison was conducted in a sample of 2,880 participants who were included in a MESA substudy which genotyped the ApoE alleles. A kappa of 0.965 resulted showing excellent agreement between the ApoE isoforms estimated from snps and the genotyped results.

Statistical Analyses

As the focus of this manuscript is to describe the distribution of cognitive scores across demographic characteristics, particularly those related to socio-economic status and cultural factors, analyses were restricted to the following self-reported covariates: *Demographics* including age, gender, race/ethnicity, clinic site; *SES variables* including education, income, employment, occupational; household size, health insurance, house ownership; and c*ultural variables*: primary language, country of origin, time residing in the US, generation in the US, English spoken in the home, language of MESA exam. The addition of the ApoE4 allele was also included due to its known association with cognitive function. Descriptive statistics were calculated as the N and % or mean (SD) for categorical and continuous variables, respectively. Chi-square tests or analysis of variance (ANOVA) determined differences by race/ethnicity. Means and standard deviations of each cognitive test were analyzed and presented for all sociodemographic variables with corresponding tests of differences applied using ANOVA. General linear models were used to examine the associations between each of the cognitive tests and the sociodemographic characteristics of participants adjusted for age, gender, race/ethnicity, and education. Because of the high proportion of foreign-born non-US speakers restricted to Hispanic and Chines participants, interpretation of results by race/ethnicity is problematic. Thus, regression models were only performed in participants who selected to have the baseline exam completed in English assuring greater comparability. While raw scores were used as the outcome in models assessing the DSC and DS, the CASI was log-transformed in order to better approximate a normal distribution. Forward and backward DS scores were analyzed separately since they assess somewhat different aspects of memory. We present unstandardized beta coefficients, standard errors and p-values for each model. Effect size is shown as Cramer's V or unstandardized regression coefficients in the tables. Stata 12.0 was used to perform statistical analyses.

RESULTS

Exam 5 Sample Characteristics

During the 5th MESA examination, the CASI was completed by 4,591 participants across the six centers resulting in a completion rate of 96.8% of those returning for this follow-up visit. A total of 1,868 (40.7%) Non-Hispanic White, 1,212 (26.4%) Non-Hispanic Black, 984 (21.4%) Hispanic, and 527 (11.5%) Chinese participants completed the test. The DS was completed by 4,577 participants for a 98.3% completion rate, while 4,164 (89.5%) individuals completed the DSC. The mean age of participant who completed the cognitive evaluation was 70.3 years (SD 9.5) and 53.1% were female (Table 1). Significant differences were found across racial/ethnic groups for all socioeconomic characteristics. Whites achieved a higher level of education than the other groups with 54.9% completing college or attending graduate school compared to 43.0% of Chinese, 36.8% of Blacks, 11.1% of Hispanics ($\chi^2_{(12)}$=958.8; p <0.001). Whites also had higher income than other racial/ethnic groups with 27.6% reporting household income greater than or equal to $100,000 compared to 13.4% Chinese, 9.8% Blacks, and 18.0% Hispanics ($\chi^2_{(12)}$=740.7; p <0.001) . Only 2.8% of white participants did not have health care insurance coverage while 17.3% of Chinese, 6.6% of Blacks, and 13.6% of Hispanics had none ($\chi^2_{(15)}$=372.7; p <0.001). A large difference in immigration status of MESA participants was apparent with only 7.2% of Whites but almost all Chinese (95.6%) born outside of the US; about two-thirds of Hispanics (65.7%) and 10.3% of Blacks immigrated to the US ($\chi^2_{(12)}$=3200.0; p <0.001). Almost all Whites and Blacks spoke English as the primary language in their homes (> 99%) compared to 44.8% of Chinese and 71% of Hispanics ($\chi^2_{(3)}$=1500.0; p <0.001). A difference in carriers of the ApoE4 allele was also found with Blacks having the highest prevalence (34.5%) compared to 24.0% in Whites, 17.2% in Chinese and 20.5% in Hispanics ($\chi^2_{(12)}$=330.1; p <0.001).

Cognitive Test Scores, Demographic and Socioeconomic Characteristics

Mean scores for the three cognitive tests are shown in Table 2 by selected covariates. In general, cognition scores differed across socioeconomic and cultural variables as would be expected with higher scores found in those with greater education and income and lower scores in those less familiar with the English language and who have spent less time in the US. Carriers of the ApoE4 allele only performed slightly worse on the tests than did those without this allele; E4/4 allele carriers scored an average of 85.7 (SD 10.7) on the CASI compared to 87.0 (SD 11.4) by E3/3 carriers ($F_{(3, 4586)}$=3.6; p=0.03). Scores on the DSC, Digit Span Forward and Digit Span Backward were 14.4 (3.9) vs. 15.4 (4.6) ($F_{(4, 4154)}$=2.7; p=0.03), 9.2 (2.4) vs 9.7 (2.9) ($F_{(4, 4565)}$=2.7; p=0.03 , and 5.2 (2.2) vs. 5.6 (2.4) ($F_{(4, 4565)}$=2.1; p=0.08) for E4/4 and E3/3 carriers, respectively.

Table 3 represents associations between the cognitive test scores and selected sociodemographic and cultural variables using multiple linear regression adjusted for age, gender, race/ethnicity and education in English speaking MESA participants. Across all three cognitive tests, age and education were consistently associated with cognitive scores after adjusting for other covariates. Cognitive performance decreased as age increased and as educational attainment decreased. However, differences in associations for some of the other factors were observed for specific tests. These are briefly discussed below.

While men and women performed equally on the CASI (B=0.002, SE=0.09, $t_{(3682)}$=0.24, p=0.81), some differences by race/ethnicity were observed by test. After adjustments for age, race/ethnicity and education, men performed significantly poorer on the DSC (B=-4.43, SE=0.48, $t_{(3295)}$=-9.33, p<0.001) and DS Backward (B=-0.22, SE=0.07, $t_{(3662)}$=-3.12, p=0.002) while performing slightly better on the DS Forward (B=0.19, $t_{(3662)}$=-2.48, SE=0.08, p=0.01). In terms of ethnicity, Chinese participants scored similarly to Whites on the CASI (B=-0.04, SE=0.03, $t_{(1973)}$=-1.50, p=0.13), but scored an average 4 points better on the DSC (B=4.44, SE=1.37, $t_{(1768)}$=-3.25, p=0.001) and slightly lower (DS Forward: B=-1.16, SE=0.23, $t_{(1966)}$=-5.05, p<001; DS Backward: B=-0.80, SE=0.21, $t_{(1966)}$=-3.81, p<0.001) on the memory tasks. Non-Hispanic Blacks and Hispanics scored lower on all four tests than did Whites (CASI: B=-0.06, SE=0.01, $t_{(3068)}$=-5.02, p<0.001; DSC:B=-10.08, SE=0.54, $t_{(2709)}$=-18.61, p<0.001; DS Forward: B=-0.38, SE=0.09, $t_{(3056)}$=-4.39, p<0.001; DS Backward: B=-1.17, SE=0.08, $t_{(3056)}$=-14.61, p<001). While these associations were adjusted for age, gender and education, it is important to keep in mind that many other important factors that influence cognition were not controlled in this study but will be examined in future papers.

Other economic variables ranged in strength of associations after controlling for age, gender, race/ethnicity, and education. Household income did not generally show associations with the CASI, while scores on the DSC ($50,000-$99,999: B=4.05, SE=0.87, $t_{(1443)}$=4.67, p<001; and > $100,000: B=6.73, SE=1.00, $t_{(999)}$=-6.71, p<0.001) and DS Backward ($50,000-$99,999: B=0.45, SE=0.13, $t_{(1595)}$=3.43, p=001; and > $100,000: B=0.65, SE=0.15, $t_{(1116)}$=4.37, p<0.001) were related to household income. The DSC scores were also related to median neighborhood income (B=0.62, SE=0.11, $t_{(3295)}$=5.64, p<0.001). Having no health insurance was inversely related to scoring on the DSC (B=-3.55, SE=1.25, $t_{(3186)}$=-3.09, p=002) and DS Forward (B=-0.49, SE=0.19, $t_{(2415)}$=-2.64, p=0.008) compared to having private health care coverage. Having two persons living in a household resulted in improved scores on the DSC compared to a single-person household (B=1.48, SE=0.56, $t_{(2489)}$=2.62, p=0.009).

Cultural factors in these analyses of English-speaking participants focused on birthplace and time living in the US. Persons born in the US, regardless of the region of birth, scored significantly better on the DSC than did those born in other countries (US West: B=10.32, SE=1.11, $t_{(690)}$=9.30, p < 0.001; US Midwest: B=6.73, SE=0.0.81, $t_{(1485)}$=8.29, p<0.001; US South: B=3.39, SE=0.82, $t_{(1643)}$=4.14, p<0.001; US Northeast: B=5.73, SE=0.96, $t_{(900)}$=6.00, p<0.001). First generation immigrants performed worse on the DSC than did those who had been in the US four generations or longer (B=-5.77, SE=0.82, $t_{(2010)}$=-7.03, p<0.001). While first generation participants scored about the same on the memory tests as those in the US for 4 or more generations (DS Forward: B=0.04, SE=0.14, $t_{(2493)}$=3.64, p=0.79; DS Backward: B=0.16, SE=0.12, $t_{(2233)}$=1.28, p=0.20), second generation (DS

Forward: B=0.57, SE=0.13, $t_{(2290)}$=4.41, p<0.001; DS Backward: B=0.45, SE=0.12, $t_{(2290)}$=3.96, p<0.001) and third generation (Digit Span Forward: B=0.40, SE=0.11, $t_{(2493)}$=3.64, p<0.001) did better than others. Compared to US born, immigrants living 30 years or longer in the US performed more poorly on the DSC (B=-5.37, SE=0.96, $t_{(3150)}$=-5.62, p<0.001). Persons carrying at least one copy of the ApoE E4 allele performed significantly worse than those with two E3 alleles on the DSC (B=-1.80, SE=0.56, $t_{(2688)}$=-3.20, p=0.001), DS Forward (B=-0.39, SE=0.09, $t_{(3090)}$=-4.25, p<0.001) and DS Backward (B=-0.25, SE=0.08, $t_{(3090)}$=-3.02, p=0.002). A strong associations was not found between the ApoE E4 carriers and the CASI perhaps due to the language orientation of the test (B=-0.03, SE=0.01, $t_{(3101)}$=-2.00, p=0.04).

CONCLUSION

In this study of cognitive performance in the MESA cohort, we found a number of differences among the four racial/ethnic groups that could affect performance on cognitive tests directly or indirectly. Our examination of the unadjusted associations between socio-economic factors and mean cognitive functioning scores revealed that age, education, household income, health insurance, number in the household, place of birth, years in the US, English spoken in the home, generation in the US, and occupational status were significantly and robustly associated with performance on the cognitive tests representing key cognitive domains. Our multivariate regression revealed cognitive performance to be consistently and robustly related to age, race/ethnicity and education but less consistently associated with household income, health insurance, number in household, place of birth, generations in U.S., years in U.S., and APOE4 carrier status. For these socio-cultural factors the pattern varied across tests suggesting that cognitive abilities may be differentially sensitive to these factors. For example, gender was more strongly related to processing speed (DSC) and the more difficult working memory test (Digit Span Backward) with men performing slightly poorer. In terms of racial/ethnic differences, Non-Hispanic Blacks and Hispanics scored lower across domains compared to Non-Hispanic Whites, while Chinese performed better in terms of processing speed, poorer in memory but did not differ from Whites on global cognition. While no differences in global cognition performance (CASI) were found for any specific socioeconomic or cultural variable besides education, lack of health insurance was found to be related to poorer performance in each of these domains. Cultural variables (i.e. place of birth, time in the US) showed the greatest association with processing speed results (DSC). Compared to E3/E3 carriers, individuals who carried an ApoE4 allele scored more poorly in the domain specific tests than on overall global cognition.

The current study found commonly-observed patterns of cognitive test score differences among racial and ethnic groups. A discussion of contributors to this pattern is beyond the scope of this paper, and the reader is referred elsewhere for comprehensive empirical reviews and analyses (e.g. 21-23). However, known contributors are complex, multifactorial, and include the characteristics of the initial test development and validation samples, educational attainment, educational quality, geographic region, acculturation, and culture of the testing environment itself (22-25). In addition, due to patterns of incongruence between impaired cognitive performance scores and behavioral function in minority samples, the clinical validity of meaning ascribed to lower cognitive scores in these groups is also an issue of concern (21, 22).

Although there is a body of literature demonstrating that adjusting for one or more of the contributing factors, particularly education-related variables, can attenuate or even eliminate racial/ethnic differences in cognitive performance (26-28), many of the influencing cultural and socioeconomic factors cannot be adequately quantified or accounted for with statistical approaches (21,25). As a result, caution has been recommended with regard to comparison and interpretation of racial/ethnic group performance differences from cross-sectional data (21). It can be argued that a more reliable approach to cognition research across racial/ethnic and cultural groups may be to examine intra-individual patterns of changes in cognition longitudinally (something hopefully possible in the future via longitudinal MESA cognitive assessments).

The current study provides baseline data for each racial/ethnic group in MESA. The data are not presented for the purpose of interpreting cognitive performance differences between groups at baseline. Rather, these data will be used for future analyses of patterns of cognitive decline among and within groups, including analyses stratified by ethnicity, and will allow identification of differential or similar effects of key variables contributing to cognitive decline longitudinally. These data can also be used to characterize the associations between cognition and the health outcomes measured in MESA. Far less is known about language and cultural influences on cognition function. While it is obvious that persons being tested outside of their primary language may not perform optimally, the extent to which non-native but perhaps fluent language skills have on testing is unknown. There are also other cultural influences that may affect both true cognitive development during childhood in addition to testing ability.

Although the CASI was developed and validated in Chinese and Spanish, it is still very possible that language and cultural biases exist. We tried to eliminate some of these potential biases by including tests in the MESA cognitive battery that relied on parameters other than verbal understanding, such as the DSC which utilizes symbols to measure processing speed and the DS which only use series of numbers to assess memory. However, it is still possible that misunderstandings based on instructions provided by the administrator or other issues may have impacted scoring results. The quality control provided by development of a manual of operations, monitoring and reviewing of technician administration, regular conference calls and retraining when needed were instituted to reduce error caused by this.

Strengths of the MESA cohort include the large sample size and excellent retention in the 5^{th} follow-up examination over a decade later. The inclusion of four racial/ethnic groups within the same set of standardized interviews and procedures also allows more direct comparisons by group than could be made between different cohorts or studies. MESA collected a large variety of sociodemographic and cultural measurements in an attempt to better understand clinical differences by race; those same measures were available for use in evaluating sources of differences in cognition. However, limitations of these data from a social or cultural perspective, as discussed above, remain. It is also possible that residual confounding within variables exists. As multiple testing increased the probability of chance findings, this should be considered when viewing results especially for weak association. Small sample size within cells may also have affected results of regression analyses. We did not include tests of interactions between the many variables presented here which assumes equal relationships and is a limitation of the analyses. It should also be noted that as MESA participants were not a random sample but were recruited in a variety of ways, results may not be generalizable to other populations. Regardless, the results provided here reflect a sound analytic approach to evaluating sociodemographic influences on cognitive function in a multi-ethnic cohort of older adults.

While results of the analyses presented here cannot be considered conclusive due to the many variables that were not included in models, the objectives of this study were met in providing methodologies and preliminary results of cognitive testing in the MESA cohort. In addition to providing a baseline for future exams, these data will be investigated more comprehensively in follow-up papers that will focus on individual topics affecting cognitive processes including environmental factors such as subclinical and clinical diseases, lifestyle behaviors, laboratory risk factors, as well as genetics. The measurement of cognitive function in MESA presents an important opportunity to delve further into a better understanding of factors that influence cognitive performance and to ultimately address interventions for prevention of cognitive decline.

Acknowledgments

Source of Funding: This research was supported by contracts N01-HC-95159, N01-HC-95160, N01-HC-95161, N01-HC-95162, N01-HC-95163, N01-HC-95164, N01-HC-95165, N01-HC-95166, N01-HC-95167, N01-HC-95168 and N01-HC-95169 from the National Heart, Lung, and Blood Institute; by grants UL1-TR-000040 and UL1-RR-025005 from NCRR; and by P60 MD 00206 from NIMHD. The authors thank the other investigators, the staff, and the participants of the MESA study for their valuable contributions. A full list of participating MESA investigators and institutions can be found at http://www.mesa-nhlbi.org. MESA provides funding through one or more of these sources to Drs. Fitzpatrick, Alonso, Carnethon, Gottesman, Rapp, Seeman, Sharrett, and Ms. Williams.

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Table 1

Characteristics of MESA participants completing cognitive testing in 2011-12.

	Race/Ethnicity						
	Non-Hispanic White	Chinese	Non-Hispanic Black	Hispanic	Total	Test Statistic* (p)	Effect Size** (Sig.)
N	**1,868**	**527**	**1,212**	**984**	**4,591**		
	N (%) or Mean (SD)	**N (%) or Mean (SD)**	**N (%) or Mean (SD)**	**N (%) or Mean (SD)**	**N (%) or Mean (SD)**		
Age (years)	70.6 (9.5)	69.9 (9.5)	70.3 (9.3)	69.7 (9.7)	70.3 (9.5)	$F_{(3, 4587)}$= 2.3 (0.08)	
Age Group (years)							
55-64	609 (32.6)	181 (34.3)	39 (32.4)	348 (35.4)	1531 (33.3)	$X^2_{(9)}$= 6.9 (0.65)	ϕ_c=0.022 (0.65)
65-74	566 (30.3)	163 (30.9)	383 (31.6)	302 (30.7)	1,414 (30.8)		
75-84	536 (28.7)	142 (26.9)	345 (28.5)	248 (25.2)	1,271 (27.7)		
85-94	157 (8.4)	41 (7.8)	91 (7.5)	86 (8.7)	375 (8.2)		
Gender							
Female	968 (51.8)	262 (49.7)	689 (56.8)	521 (52.9)	2,440 (53.1)	$X^2_{(3)}$= 10.5 (0.02)	ϕ_c=0.048 (0.02)
Male	900 (48.2)	265 (50.3)	523 (43.2)	463 (47.1)	2,151 (46.9)		
Education							
LT High School	63 (3.4)	104 (19.7)	111 (9.2)	372 (37.8)	650 (14.2)	$X^2_{(12)}$= 958.8 (<0.001)	ϕ_c=0.264 (<0.001)
HS Graduate	284 (15.2)	82 (15.6)	217 (18.0)	214 (21.7)	797 (17.4)		
Some College	494 (26.5)	114 (21.6)	435 (36.0)	289 (29.4)	1,332 (29.1)		
College Graduate	446 (23.9)	123 (23.3)	223 (18.5)	60 (6.1)	852 (18.6)		
Post Graduate	579 (31.0)	104 (19.7)	221 (18.3)	49 (5.0)	953 (20.8)		
Household Income ($)							
LT $20,000	153 (8.3)	179 (43.2)	185 (16.4)	314 (32.3)	831 (18.6)	$X^2_{(12)}$= 740.7 (<0.001)	ϕ_c=0.48 (<0.001)
$20,000-34,999	239 (13.0)	103 9(19.7)	258 (22.8)	289 (29.7)	889 (19.9)		
$35,000-49,999	310 (16.9)	57 (10.9)	210 (18.6)	166 (17.1)	743 (16.7)		
$50,000-$99,999	626 (34.1)	115 (22.0)	366 (32.4)	175 (18.0)	1,282 (27.7)		
GE $100,000	507 (27.6)	70 (13.4)	111 (9.8)	175 (18.0)	716 (16.1)		
Health Insurance							
Private	1,142 (61.4)	260 (49.3)	712 (59.1)	519 (53)	2,633 (57.6)	$X^2_{(15)}$= 372.7 (<0.001)	ϕ_c=0.166 (<0.001)

	Race/Ethnicity						
	Non-Hispanic White	Chinese	Non-Hispanic Black	Hispanic	Total	Test Statistic * (p)	Effect Size ** (Sig.)
N	**1,868**	**527**	**1,212**	**984**	**4,591**		
	N (%) or Mean (SD)	**N (%) or Mean (SD)**	**N (%) or Mean (SD)**	**N (%) or Mean (SD)**	**N (%) or Mean (SD)**		
Medicaid	1 (0.1)	13 (2.5)	8 (0.7)	33 (3.4)	55 (1.2)		
Medicare + Suppl	404 (21.7)	39 (7.4)	223 (18.5)	95 (9.7)	761 (16.6)		
Medicare no Suppl	210 (11.2)	107 (20.3)	140 (11.6)	162 (16.5)	619 (13.5)		
VA/Other	52 (2.8)	17 (3.2)	41 (3.4)	38 (3.9)	148 (3.2)		
None	52 (2.8)	91 (17.3)	80 (6.6)	134 (13.6)	357 (7.8)		
Number in Household							
One	517 (27.8)	64 (12.1)	432 (36.1)	264 26.9)	1,277 (28.1)	$X^2_{(9)}$= 260.0 (<0.001)	φ_c=0.138 (<0.001)
Two	960 (51.7)	235 (44.6)	468 (39.1)	349 (35.5)	2,012 (44.1)		
Three-Four	317 (17.1)	171 (32.4)	236 (19.7)	263 (26.8)	987 (21.6)		
Five or more	64 (3.4)	57 (10.8)	61 (5.1)	107 (10.9)	289 (6.3)		
Place of Birth							
US - West	82 (4.4)	9 (1.7)	33 (2.7)	105 (10.7	229 (5.0)	$X^2_{(12)}$= 3200.0 (<0.001)	φ_c=0.485 (<0.001)
US - Midwest	794 (42.5)	13 (2.5)	137 (11.3)	146 (14.8)	1090 (23.7)		
US - South	537 (28.7)	0 (0.0)	798 (65.8	54 (5.5)	1389 (30.3)		
US - Northeast	320 (17.1)	1 (0.2)	119 (9.8)	33 (3.4)	473 (10.3)		
Foreign-born	135 (7.2)	504 (95.6)	125 (10.3)	646 (65.7)	1410 (30.7)		
Years in the US							
US born	1764 (94.4)	60 (11.4)	1123 (92.7)	415 (42.2)	3362 (73.2)	$X^2_{(9)}$= 2500.0 (<0.001)	φ_c=0.430 (<0.001)
LT 15 years	14 (0.7)	161 (30.6)	8 (0.7)	80 (8.1)	263 (5.7)		
15-20 years	17 (0.9)	193 (36.6)	42 (3.5)	170 (17.3)	422 (9.2)		
30 years or more	73 (3.9)	113 (21.4)	39 (3.2)	319 (32.4)	544 (11.8)		
English Spoken at Home	1853 (99.2)	236 (44.8)	1208 (99.7)	699 (71.0)	3996 (87.0)	$X^2_{(3)}$= 1500.0 (<0.001)	φ_c=0.567 (<0.001)
Language at MESA exam	1868 (100.0)	110 (20.9)	1211 (99.9)	498 (50.6)	3687 (80.3)	$X^2_{(6)}$= 5476.0 (<0.001)	φ_c=0.772 (<0.001)
English	0 (0.0)	0 (0.0)	0 (0.0)	486 (49.4)	486 (10.6)		
Spanish	0 (0.0)	417 (79.1)	1 (0.1)	0 (0.0)	418 (9.1)		
Mandarin/Cantonese							

	Race/Ethnicity						
	Non-Hispanic White	Chinese	Non-Hispanic Black	Hispanic	Total	Test Statistic* (p)	Effect Size** (Sig.)
N	**1,868**	**527**	**1,212**	**984**	**4,591**		
	N (%) or Mean (SD)	N (%) or Mean (SD)	N (%) or Mean (SD)	N (%) or Mean (SD)	N (%) or Mean (SD)		
Generation in US							
First	130 (7.1)	504 (95.6)	116 (10.1)	645 (66.0)	1395 (31.2)	$X^2_{(9)}$= 3458.0 (<0.001)	ϕ_c=0.507 (<0.001)
Second	306 (16.8)	21 (4.0)	23 (2.0)	211 (21.6)	561 (12.6)		
Third	618 (34.0)	2 (0.4)	47 (4.1)	95 (9.7)	762 (17.1)		
Fourth or more	765 (42.1)	0 (0.0)	957 (83.7)	26 (2.7)	1748 (39.1)		
Occupation							
Homemaker	187 (10.3)	69 (13.1)	64 (5.3)	119 (121)	439 (9.6)	$X^2_{(15)}$= 185.8 (<0.001)	ϕ_c=0.116 (<0.001)
Working FT	856 (45.9)	235 (44.6)	547 (45.4)	423 (43)	2061 (45.0)		
Working PT	223 (12.0)	61 (11.6)	74 (6.1)	88 (8.9)	446 (9.7)		
Unemployed/on leave	42 (2.3)	13 (2.5)	48 (4.0)	46 (4.7)	149 (3.3)		
Retired-not working	287 (15.4)	126 23.2)	287 (23.8)	237 (24.1)	937 (20.4)		
Retired-working/volunteering	270 (14.5)	23 (4.4)	186 (15.4)	71 (7.2)	550 (12.0)		
ApoE allele							
ApeE 3/3	1158 (62.0)	369 (73.8)	565 (46.6)	692 (70.0)	2804 (61.1)	$X^2_{(12)}$= 330.1 (<0.001)	ϕ_c=0.241 (<0.001)
ApoE 2/3	187 (10.0)	21 (4.0)	85 (7.0)	53 (5.4)	346 (7.5)		
ApoE 4/4	40 (2.1)	4 (0.8)	46 (3.8)	13 (0.3)	103 (2.2)		
ApoE 2/4*** or 3/4	417 (22.3)	92 (17.5)	330 (27.2)	193 (19.6)	1032 (22.5)		
Missing	66 (3.5)	21 (4.0)	186 (15.3)	33 (3.4)	306 (6.7)		

* Chi-square test (degrees of freedom) or F-test (degrees freedom model) are presented.

** Cramer's V and level of significance are shown.

*** only 3 participants had ApoE 2/4 genotype

Table 2

Mean cognitive scores by demographics and socioeconomic characteristics of the MESA cohort: CASI, DSC and Digit Spans Forward and Backward.

	CASI				DSC				DIGIT SPAN						
										Forward			Backward		
	N	Mean (SD)	B (SE)	Test Statistic* (p)	N	Mean (SD)	B (SE)	Test Statistic* (p)	N	Mean (SD)	B (SE)	Test Statistic* (p)	Mean (SD)	B (SE)	Test Statistic* (p)
Age Group (years)															
55-64	1531	89.1 (11.1)	(reference)	F= 75.7 df=3,4587 (<0.001)	404	59.2 (17.4)	(reference)	F=315.8 df=3,4155 (<0.001)	1528	10.0 (2.8)	(reference)	F = 27.8 df=3,4566 (<0.001)	6.0 (2.5)	(reference)	F = 39.0 df=3,4566 (<0.001)
65-74	1414	87.9 (10.4)	−1.17 (0.41)		1293	51.2 (16.6)	−7.98 (0.64)		1410	9.7 (2.8)	−0.33 (0.10)		5.7 (2.4)	−0.34 (0.08)	
75-84	1271	84.8 (11.6)	−4.34 (0.42)		1136	42.7 (16.4)	−16.52 (0.67)		1267	9.4 (2.7)	−0.67 (0.10)		5.2 (2.2)	−0.76 (0.08)	
85-94	375	81.0 (12.4)	−8.15 (.64)		331	33.9 (16.3)	−25.34 (1.02)		372	8.7 (2.7)	−1.29 (0.16)		4.8 (2.1)	−1.19 (0.13)	
Gender															
Female	2440	86.5 (11.7)	(reference)	F= 4.56 df=1,4589 (0.03)	2223	51.1 (19.2)	(reference)	F= 9.8 df=1,4157 (0.001)	2433	9.5 (2.8)	(reference)	F= 12.7 df=1,4568 (0.004)	5.6 (2.4)	(reference)	F= 0.08 df=1,4568 (0.77)
Male	2151	87.2 (11.0)	0.72 (0.34)		1941	49.2 (19.0)	−1.81 (0.57)		2144	9.8 (2.8)	0.29 (0.08)		5.6 (2.4)	0.02(0.07)	
Race/Ethnicity															
Non-Hispanic White	1868	90.8 (9.1)	(reference)	F=156.2 df=3,4587 (<0.001)	1668	56.6 (16.3)	(reference)	F= 203.9 df=3,4155 (<0.001)	1861	10.0 (2.4)	(reference)	F= 356.2 df=3, 4566 (<0.001)	6.4 (2.3)	(reference)	F=240.7 df=3,4566 (<0.001)
Chinese	527	84.5 (12.1)	−6.33 (0.53)		499	56.2 (18.6)	−0.40 (0.88)		524	12.1 (3.3)	2.04 (0.12)		6.1 (2.4)	−0.41 (0.10)	
Non-Hispanic Black	1212	85.4 (11.3)	−5.39 (0.40)		1052	45.2 (16.8)	−11.36 (0.68)		1211	9.5 (2.4)	−0.52 (0.09)		5.1 (2.1)	−1.34 (0.08)	
Hispanic	984	82.3 (12.5)	−8.51 (0.42)		945	41.4 (19.2)	−15.18 (0.70)		981	7.8 (2.4)	−2.23 (0.09)		4.3 (2.0)	−2.20 (0.08)	
Education															
LT High School	650	77.0 (13.6)	(reference)	F=210.3 df =4,4579 (<0.001)	592	31.0 (15.8)	(reference)	F= 314.7 df=4,4149 (<0.001)	648	8.2 (3.1)	(reference)	F= 90.8 df=4,4558 (<0.001)	3.8 (1.9)	(reference)	F=193.6 df=4,4558 (<0.001)
HS Graduate	797	85.0 (10.7)	7.98 (0.55)		733	45.7 (16.6)	14.72 (0.90)		793	9.2 (2.7)	1.22 (0.14)		5.1 (2.0)	1.31(0.11)	
Some College	1332	87.9 (10.2)	10.88 (0.50)		1198	51.9 (16.6)	20.85 (0.82)		1328	9.7 (2.6)	1.69 (0.12)		5.6 (2.2)	1.87(0.10)	
College Graduate	852	89.8 (9.3)	12.78 (0.55)		778	56.8 (16.3)	25.77 (0.89)		848	10.3 (2.7)	2.30 (0.14)		6.3 (2.3)	2.49(0.11)	
Post Graduate	953	91.2 (9.1)	14.16 (0.53)		858	59.0 (16.1)	27.98 (0.87)		953	10.3 (2.5)	2.27 (0.14)		6.6 (2.4)	2.86(0.11)	
Household Income															
LT $20,000	831	81.0 (13.4)	(reference)	F=124.1 df =4,4456 (<0.001)	762	38.9 (18.7)	(reference)	F= 192.5 df= 4,4046 (<0.001)	826	9.2 (3.4)	(reference)	F= 29.2 df=4,4436 (<0.001)	4.6 (2.2)	(reference)	108.7 df=4,4436 (<0.001)
$20,000-34,999	889	84.9 (11.8)	3.97 (0.52)		820	46.2 (18.2)	7.16 (0.85)		890	9.2 (2.9)	−0.001(0.13)		5.1 (2.2)	.53 (0.11)	
$35,000-49,999	743	87.7 (10.0)	6.72 (0.54)		663	50.0 (16.5)	11.06 (0.90)		740	9.6 (2.5)	0.45 (0.14)		5.5 (2.3)	.90 (0.11)	
$50,000-$99,999	1282	89.3 (10.4)	8.33 (0.48)		1167	55.4 (16.2)	16.49 (0.79)		1278	10.0 (2.6)	0.80 (0.12)		6.1 (2.4)	1.47 (0.10)	
GE $100,000	716	91.8 (6.9)	10.88 (0.55)		644	61.4 (15.2)	22.47 (0.91)		714	10.4 (2.5)	1.19 (0.14)		6.8 (2.4)	2.15 (0.11)	
Health Insurance															
Private	2633	88.8 (10.6)	(reference)	F=60.2 df=5,4567 (<0.001)	2400	55.6 (17.8)	(reference)	F= 131 df=5, 4139 (<0.001)	2625	9.9 (2.7)	(reference)	F =12.0 df=5,4546 (<0.001)	6.0 (2.4)	(reference)	F= 35.4 df=5,4546 (<0.001)
Medicaid	55	77.9 (14.6)	−10.9 (1.50)		52	37.0 (20.4)	−18.61 (2.42)		55	8.8 (3.2)	−1.05 (0.38)		4.0 (2.0)	−1.96 (0.32)	

	CASI				DSC				DIGIT SPAN						
										Forward			Backward		
	N	Mean (SD)	B (SE)	Test Statistic* (p)	N	Mean (SD)	B (SE)	Test Statistic* (p)	N	Mean (SD)	B (SE)	Test Statistic* (p)	Mean (SD)	B (SE)	Test Statistic* (p)
Medicare + Suppl	761	86.4 (9.5)	−2.37 (0.45)		678	44.2 (15.8)	−11.52 (0.75)		757	9.3 (2.5)	−0.56 (0.11)		5.4 (2.1)	−.52 (0.09)	
Medicare no Suppl	619	81.1 (14.0)	−7.69 (0.49)		552	37.5 16.9)	−18.08 (0.81)		617	9.1 (3.0)	−0.77 (0.12)		4.9 (2.2)	−1.08 (0.10)	
VA/Other	148	87.9 (7.7)	−0.89 (0.93)		138	48.0 (17.6)	−7.65 (1.51)		148	9.7 (2.7)	−0.18 (0.23)		5.3 (2.3)	−0.61 (0.19)	
None	357	84.7 (12.1)	−4.04 (0.62)		330	47.4 (17.3)	−8.23 (1.01)		357	9.4 (3.5)	−0.47 (0.15)		5.0 (2.3)	−0.98 (0.13)	
Number in Household															
One	1277	85.6 (12.2)	(reference)	F= 9.9 df=3,4561 (<0.001)	1143	46.2 (19.0)	(reference)	F= 30.5 df=3,4136 (<0.001)	1274	9.4 (2.7)	(reference)	F= 8.4 df=3,4540 (<0.001)	5.4 (2.4)	(reference)	F= 7.83 df=3,4540 (<0.001)
Two	2012	87.6 (10.4)	2.00(0.41)		1840	50.9 (17.3)	4.60 (0.69)		2004	9.7 (2.7)	0.33 (0.10)		5.6 (2.3)	0.22 (0.08)	
Three-Four	987	87.3 (11.7)	1.69(0.48)		893	54.0 (18.8)	7.67 (0.82)		984	9.9 (3.0)	0.56 (0.11)		5.8 (2.5)	0.38 (0.10)	
Five or more	289	85.6 (12.8)	−.09(0.73)		269	50.6 (21.6)	4.33 (1.24)		289	9.5 (3.2)	0.10 (0.18)		5.2 (2.5)	−0.22 (0.15)	
Place of Birth															
US - West	229	87.5 (13.8)	(reference)	F=74.6 df=4,4586 (<0.001)	220	57.6 (17.6)	(reference)	F= 81.1 df=4, 4154 (<0.001)	228	9.4 (2.6)	(reference)	F = 4.6 df=4,4565 (0.001)	5.6 (2.4)	(reference)	F= 44.9 df=4,4565 (<0.001)
US - Midwest	1090	90.2 (9.2)	2.68 (0.80)		1013	56.4 (16.3)	−1.18 (1.33)		1084	9.7 (2.4)	0.30 (0.20)		6.1 (2.3)	0.51 (0.17)	
US - South	1389	87.0 (11.3)	−0.56 (0.78)		1168	47.6 (17.3)	−9.97 (1.31)		1383	9.6 (2.4)	0.12 (0.19)		5.5 (2.2)	−0.11 (0.16)	
US - Northeast	473	89.8 (9.8)	2.25 (0.88)		429	55.2 (15.6)	−2.39 (1.48)		472	10.1 (2.5)	0.65 (0.22)		6.4 (2.5)	0.81 (0.18)	
Foreign-born	1410	83.1 (11.9)	−4.42 (0.78)		1329	45.0 (20.2)	−12.51 (1.30)		1403	9.5 (3.5)	0.09 (0.19)		5.1 (2.4)	−0.50 (0.16)	
Years in the US															
US born	3362	88.2 (10.9)	(reference)	F=57.2 df=3,4587 (<0.001)	2999	52.1 (17.7)	(reference)	F= 51.0 df=3,4155 (<0.001)	3354	9.6 (2.5)	(reference)	F=48.7 df=3,4566 (<0.001)	5.8 (2.3)	(reference)	F= 29.3 df=3,4566 (<0.001)
LT 15 years	263	82.9 (12.0)	−5.32 (0.71)		247	49.2 (19.8)	−2.91 (1.21)		263	11.0 (3.8)	1.32 (0.17)		5.4 (2.6)	−0.37(0.15)	
15-20 years	422	83.7 (12.8)	−4.45 (0.57)		405	47.8 (20.9)	−4.38 (0.96)		419	10.1 (3.7)	0.44 (0.14)		5.3 (2.5)	−0.51 (0.12)	
30 years or more	544	83.2 (10.9)	−4.96 (0.51)		513	41.6 (18.7)	−10.47 (0.87)		541	8.6 (2.9)	−1.02(0.12)		4.8 (2.3)	−0.95 (0.10)	
English Spoken at Home															
No	595	81.8 (12.1)	(reference)	F=140.0 df=1,4589 (<0.001)	563	41.6 (21.1)	(reference)	F=145.6 df=1,4157 (<0.001)	592	9.8 (3.8)	(reference)	F= 1.6 df=1,4568 (0.21)	4.8 (2.4)	(reference)	F= 71.3 df=1,4568 (<0.001)
Yes	3996	87.6 (11.1)	5.83 (0.49)		3601	51.6 (17.8)	10.02 (0.83)		3985	9.6 (2.6)	−0.15 (0.12)		5.7 (2.4)	0.88 (0.10)	
Language at MESA exam															
English	3687	88.2 (10.6)	(reference)	F=158.2 df=2,4588 (<0.001)	3305	52.4 (17.4)	(reference)	F=305.5 df=2,4256 (<0.001)	3677	9.6 (2.4)	(reference)	F=617.7 df=2,4567 (<0.001)	5.8 (2.3)	(reference)	F= 187.9 df=2,4567 (<0.001)
Spanish	486	79.4 (12.3)	−8.87 (0.53)		464	31.4 (16.2)	−21.03 (0.86)		485	7.0 (2.3)	−2.61(0.11)		3.7 (1.8)	−2.08 (0.11)	
Mandarin/Cantonese	418	83.7 (12.8)	−4.51 (0.56)		395	53.7 (18.3)	1.17 (0.92)		415	12.8 (3.0)	3.21 (0.12)		6.1 (2.5)	0.29 (0.11)	
Generation in US															
First	1395	83.1 (11.9)	(reference)	F=58.3 df=3,4462 (0.001)	1319	45.1 (20.3)	(reference)	F= 72.3 df=3,4058 (<0.001)	1389	9.5 (3.5)	(reference)	F= 5.8 df=3,4441 (0.001)	5.1 (2.4)	(reference)	F= 37.6 df=3,4441 (<0.001)
Second	561	88.0 (8.6)	4.95 (0.55)		516	52.2 (17.3)	7.22 (0.94)		562	9.5 (2.5)	0.01 (0.13)		5.9 (2.4)	0.80 (0.11)	
Third	762	90.2 (10.9)	7.07 (0.49)		686	57.2 (16.3)	12.20 (0.85)		758	10.1 (2.4)	0.55 (0.12)		6.3 (2.4)	1.25 (0.10)	

	CASI				DSC				DIGIT SPAN						
										Forward			Backward		
	N	Mean (SD)	B (SE)	Test Statistic* (p)	N	Mean (SD)	B (SE)	Test Statistic* (p)	N	Mean (SD)	B (SE)	Test Statistic* (p)	Mean (SD)	B (SE)	Test Statistic* (p)
Fourth or more	1748	88.0 (11.2)	4.96 (0.39)		1546	50.8 (17.4)	5.77 (0.68)		1743	9.6 (2.4)	0.05 (0.10)		5.6 (2.3)	0.52 (0.08)	
Occupation															
Homemaker	439	85.0 (12.9)	(reference)	F= 38.5 df=5,4576 (<0.001)	397	47.0 (18.6)	(reference)	F=120.8 df=5,4146 (<0.001)	441	9.2 (2.9)	(reference)	F= 5.9 df=5,4555 (<0.001)	5.2 (2.4)	(reference)	F= 29.3 df=5,4555 (<0.001)
Working FT	2061	88.8 (10.6)	3.74 (0.58)		1884	56.3 (17.0)	9.30 (0.96)		2054	10.0 (2.8)	0.79 (0.14)		5.9 (2.4)	0.71 (0.12)	
Working PT	446	88.2 (11.4)	3.17 (0.75)		403	53.2 (19.5)	6.15 (1.23)		445	9.8 (2.9)	0.62 (0.18)		6.0 (2.5)	0.76 (0.15)	
Unemployed/on leave	149	87.6 (8.2)	2.56 (1.05)		137	48.4 (17.4)	1.37 (1.72)		150	9.5 (2.8)	0.31 (0.26)		5.4 (2.5)	0.22 (0.22)	
Retired-not working	937	83.0 (12.7)	−2.04 (0.64)		842	39.5 (17.2)	−7.49 (1.06)		929	9.1 (2.8)	−0.04 (0.16)		4.9 (2.1)	−0.29 (0.13)	
Retired-working/volunteering	550	86.8 (9.8)	1.79 (0.71)		494	46.0 (16.5)	−1.02 (1.17)		549	9.4 (2.4)	.026 (0.17)		5.4 (2.2)	0.14 (0.15)	
ApoE allele															
ApeE 3/3	2804	87.0 (11.4)	(reference)	F= 3.6 df=4,4586 (0.03)	2797	15.4 (4.6)	(reference)	F= 2.7 df=4,4154 (0.03)	2797	9.7 (2.9)	(reference)	F= 2.7 df=4,4565 (<0.03)	5.6 (2.4)	(reference)	F= 2.1 df=4,4565 (0.08)
ApoE 2/3	346	88.2 (9.9)	1.17 (0.64)		344	15.4 (4.5)	−.09 (1.10)		344	9.6 (2.6)	−0.09 (0.15)		5.8 (2.5)	0.14 (0.13)	
ApoE 4/4	103	85.7 (10.7)	−1.36 (1.14)		102	14.4 (3.9)	−3.64 (1.93)		102	9.2 (2.4)	−0.55 (0.28)		5.2 (2.2)	−0.39 (0.24)	
ApoE 2/4** or 3/4	1032	86.1 (12.6)	−0.91 (0.41)		1026	14.9 (4.5)	−1.12 (0.71)		1026	9.4 (2.8)	−0.28 (0.10)		5.5 (2.3)	−0.14 (0.08)	
Missing	306	86.8 (8.0)	−0.26 (0.68)		308	15.0 (3.9)	−1.41 (1.18)		308	9.6 (2.4)	−0.12 (0.16)		5.4 (2.2)	−0.20 (0.14)	

* F-test (degrees freedom model) are presented.

** only 3 participants had ApoE 2/4 genotype

Table 3

Multivariate associations between cognitive test scores and sociodemographic characteristics in English-speaking participants of the MESA cohort adjusted for age, gender, race and education. Unstandardized Beta coefficient (Coeff), standard error (SE), Test statistic (t) and p-value (p) are shown.

	CASI				DSC				DIGIT SPANS						
										Forward			Backward		
	N	B (SE)	t	P	N	B (SE)	t	p	N	B (SE)	t	p	B (SE)	t	p
Age (years)*	3677	−0.001 (0.005)	−2.67, df=3675	0.008	3297	−0.79 (0.03)	−30.76, df=3295	<0.001	3664	−0.04 (0.004)	−9.96, df=3662	<0.001	−0.03 (0.004)	−8.76, df=3662	<0.001
Gender*															
Female	1955	(reference)			1760	(reference)			1945	(reference)			(reference)		
Male	1732	0.002 (0.09)	0.24, df=3682	0.81	1537	−4.43 (0.48)	−9.33, df=3295	<0.001	1719	0.19 (0.08)	2.48, df =3662	0.01	−0.22 (0.07)	−3.12, df =3662	0.002
Race/Ethnicity*															
Non-Hispanic White	1865	(reference)			1665	(reference)			1858	(reference)			(reference)		
Chinese	110	−0.04 (0.03)	−1.50, df=1973	0.13	105	4.44 (1.37)	3.25, df=1768	0.001	110	−1.16 (0.23)	−5.05, df=1966	<0.001	−0.80 (0.21)	−3.81, df=1966	<0.001
Non-Hispanic Black	1205	−0.06 (0.01)	−5.02, df=3068	0.001	1046	−10.08(0.54)	−18.61, df=2709	<0.001	1200	−0.38 (0.09)	−4.39, df=3056	<0.001	−1.17 (0.08)	−14.61, df=3056	<0.001
Hispanic	497	−0.05 (0,02)	−2.90, df=2360	0.004	481	−2.74 (0.73)	−3.74, df=2144	<0.001	496	−1.21 (0.12)	−9.87, df=2352	<0.001	−1.26 (0.11)	−11.22, df=2352	<0.001
Education*															
LT High School	254	(reference)			216	(reference)			252	(reference)			(reference)		
HS Graduate	634	0.11 (0.02)	5.17, df=886	<0.001	577	8.25 (1.08)	7.62, df=791	<0.001	631	0.71 (0.17)	4.06, df=881	<0.001	0.69 (0.16)	4.64, df=881	<0.001
Some College	1163	0.14 (0.02)	6.82, df=1415	<0.001	1034	12.91 (1.03)	12.59, df=1248	<0.001	1158	1.13 (0.16)	6.91, df=1408	<0.001	1.22 (0.15)	8.47, df=1408	<0.001
College Graduate	740	0.18 (0.02)	7.85, df=992	<0.001	675	15.90 (1.09)	14.57, df=889	<0.001	738	1.36 (0.17)	7.79, df=988	<0.001	1.58 (0.16)	10.18, df=988	<0.001
Post Graduate	886	0.17 (0.02)	7.95, df=1138	<0.001	795	18.77 (1.08)	17.40, df=1009	<0.001	885	1.60 (0.17)	9.29, df=1135	<0.001	1.98 (0.16)	12.92, df=1135	<0.001
Household Income															
LT $20,000	436	(reference)			387	(reference)			434	(reference)			(reference)		
$20,000-34,999	638	0.007 (0.02)	0.35, df=1072	0.73	576	1.10 (0.89)	1.23, df=961	0.22	635	−0.06 (0.15)	−0.41, df=1067	0.79	0.18 (0.13)	1.38, df=1067	0.17
$35,000-49,999	639	0.05 (0.02)	2.38, df=1073	0.02	569	1.19 (0.92)	1.30, df=954	0.19	637	0.08 (0.15)	0.57, df=1069	0.47	0.15 (0.14)	1.08, df=1069	0.28
$50,000-$99,999	1166	0.03 (0.02)	1.83, df=1600	0.07	1058	4.05 (0.87)	4.67, df=1443	<0.001	1163	0.14 (0.14)	0.97, df=1595	0.22	0.45 (0.13)	3.43, df=1595	0.001
GE $100,000	686	0.05 (0.02)	2.45, df=1120	0.01	614	6.73 (1.00)	6.71, df=999	<0.001	684	0.29 (0.16)	1.80, df=1116	0.04	0.65 (0.15)	4.37, df=1116	<0.001
Neighborhood Income	3662	0.004 (0.002)	1.66, df=3660	0.10	3291	0.62 (0.11)	5.64, df=3295	<0.001	3664	0.008 (0.02)	0.41, df=3662	0.67	0.03 (0.02)	2.01, df=3662	0.04

	CASI				DSC				DIGIT SPANS						
										Forward			Backward		
	N	B (SE)	t	P	N	B (SE)	t	p	N	B (SE)	t	p	B (SE)	t	p
Health Insurance															
Private	2258	(reference)			2039	(reference)			2249	(reference)			(reference)		
Medicare + Suppl	699	−0.01 (0.02)	−0.69, df=2955	0.49	619	−0.69 (0.80)	−0.69, df=2656	0.32	694	−0.09 (0.13)	−0.66, df=2941	0.51	−0.14 (0.12)	−1.20, df=2941	0.23
Medicare no Suppl	411	−0.03 (0.02)	−1.71, df=2667	0.09	357	−3.55 (1.25)	−3.35, df=2394	0.001	409	−0.13 (0.15)	−0.88, df=2656	0.38	−0.16 (0.14)	−1.19, df=2656	0.23
VA/Other	135	0.03 (0.03)	0.97, df=2391	0.33	125	−3.06 (1.15)	−2.85, df=2162	0.004	135	0.09 (0.21)	0.47, df=2382	0.64	−0.34 (0.19)	−1.77, df=2382	0.08
None	168	−0.02 (0.02)	−0.90, df=2424	0.37	149	−3.55 (1.25)	−3.09, df=2186	0.002	168	−0.49 (0.19)	−2.64, df=2415	0.008	−0.41 (0.17)	−2.39, df=2415	0.02
Number in HH															
One	1095	(reference)			968	(reference)			1091	(reference)			(reference)		
Two	1677	0.02 (0.01)	1.80, df=2770	0.07	1523	1.48 (0.56)	2.62, df=2489	0.009	1672	−0.15 (0.09)	−1.62, df=2761	0.10	−0.10 (0.08)	−1.23, df=2761	0.18
Three-four	717	−0.01 (0.02)	−0.62, df=1810	0.53	638	0.86 (0.73)	1.17, df=1604	0.24	713	0.06 (0.12)	0.50, df=1802	0.62	0.12 (0.11)	1.13, df=1802	0.30
Five or more	169	0.005 (0.03)	0.19, df=1262	0.85	154	−0.64 (1.22)	−0.52,df=1120	0.60	169	0.03 (0.20)	0.16, df=1258	0.88	−0.22 (0.18)	−1.21, df=1258	0.20
Birthplace															
Foreign-born	507	(reference)			475	(reference)			497	(reference)			(reference)		
US West	225	−0.02 (0.02)	−0.67, df=730	0.50	217	10.32 (1.11)	9.30, df=690	<0.001	225	0.38 (0.19)	1.99, df=720	0.05	0.11 (0.17)	0.68, df=720	0.50
US Midwest	1089	0.01 (0.02)	0.80, df=1594	0.42	1012	6.73 (0.81)	8.29, df=1485	<0.001	1083	0.16 (0.14)	1.18, df=1578	0.24	0.06 (0.12)	0.49, df=1578	0.62
US South	1385	0.005 (0.02)	0.26, df=1890	0.79	1168	3.39 (0.82)	4.14, df=1643	<0.001	1381	0.17 (0.14)	1.25, df=1876	0.21	−0.05 (0.12)	−0.37, df=1876	0.71
US Northeast	471	0.003 (0.02)	0.14, df=976	0.89	427	5.73 (0.96)	6.00, df=900	<0.001	470	0.41 (0.16)	2.55, df=965	0.01	0.30 (0.14)	2.07, df=965	0.04
Generation in US															
Fourth or More	1746	(reference)			1544	(reference)			1738	(reference)			(reference)		
Third	760	−0.01 (0.01	−1.02, df=2504	0.31	685	0.25 (0.68)	0.37, df=2227	0.71	757	0.40 (0.11)	3.64, df=2493	<0.001	0.21 (0.10)	2.04, df=2493	0.04
Second	554	0.01 (0.02)	0.38, df= 2298	0.70	508	0.82 (0.80)	1.03, df=2050	0.31	554	0.57 (0.13)	4.41, df=2290	<0.001	0.45 (0.12)	3.96, df=2290	<0.00
First	499	−0.008 (0.02)	−0.49, df=2243	0.62	468	−5.77 (0.82)	−7.03, df=2010	<0.001	497	0.04 (0.14)	0.27, df=2233	0.79	0.16 (0.12)	1.28, df=2233	10.20
Birth Origin															
US-Born	3178	(reference)			2829	(reference)			3167	(reference)			(reference)		
Foreign-Born	499	−0.005 (0.02)	−0.30, df=3675	0.77	468	−6.078 (0.74)	−8.20, df=3295	<0.001	450	−0.24 (0.12)	−1.91, df=2615	0.06	−0.04 (0.11)	−0.37, df=2615	0.71
Years in US															
US born	3270	(reference)			2913	(reference)			3259	(reference)			(reference)		

	CASI				DSC				DIGIT SPANS						
										Forward			Backward		
	N	B (SE)	t	P	N	B (SE)	t	p	N	B (SE)	t	p	B (SE)	t	p
LT 15	34	0.01 (0.05)	0.21, df=3302	0.84	31	−3.45 (2.44)	−1.41, df=2942	0.16	34	−0.52 (0.40)	−1.30, df=3291	0.19	0.27 (0.37)	0.74, df=3291	0.47
15-30	119	0.01 (0.03)	0.39, df=3387	0.69	114	−5.76 (1.35)	−4.25, df=3025	<0.001	119	0.10 (0.23)	0.43, df=3376	0.67	−0.03 (0.21)	−0.16, df=3376	0.86
30+	254	−0.001 (0.02)	−0.06, df=3522	0.95	239	−5.37 (0.96)	−5.62, df=3150	<0.001	252	−0.22 (0.16)	−1.35, df=3509	0.17	−0.03 (0.15)	−0.21, df=3509	0.82
ApoE allele															
ApeE 3/3	2156	(reference)			1934	(reference)			2150	(reference)			(reference)		
ApoE 2/3	301	0.02 (0.02)	0.90, df=2455	0.36	273	−0.74 (0.87)	−0.84, df=2205	0.40	299	−0.20 (0.14)	−1.39, df=2447	0.16	−0.15 (0.13)	−1.12, df=2447	0.28
Any ApoE 4 allele	947	−0.03 0.01)	−2.00, df=3101	0.04	756	−1.80 (0.56)	−3.20, df=2688	0.001	942	−0.39 (0.09)	−4.25, df=3090	<0.001	−0.25 (0.08)	−3.02, df=3090	0.002

*These variables are adjusted for the other three in the category (age, gender, race/ethnicity, education).